PRODUCTION PROCESS FOR *BAEL (Aegle marmelos)* READY TO SERVE(RTS) BEVERAGE

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Production Process for *Bael* (*Aegle marmelos)* Ready to Serve (RTS) Beverage

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List of abbreviations

Abbreviations	Full form
°Bx	Degrees brix
G	Grams
IU	International units
Kcal	Kilocalorie
Mg	Milligrams
MAP	Modified atmosphere packaging
RTS	Ready to serve

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Part I

Introduction

1.1 General introduction

Ready to serve juice type of beverage which are not diluted before serving. Generally, it is prepared from juice or pulp or both by mixing the sweetness (sugar), acidulants (citric acid) and colorings and flavorings materials are optional. Ready-to- drink beverage is carbonated (Thapaliya, 2004).

Bael (Aegle marmelos) is an indigenous fruit of South Asia, prevalent in countries such as Nepal, India, Bangladesh, Sri Lanka, and Pakistan. It belongs to the Rutaceae family and is widely known for its medicinal and nutritional benefits (Patel & Sharma, 2018*).* The *bael* tree is a slow-growing, medium-sized tree that can reach a height of up to 15 meters, characterized by its trifoliate leaves and aromatic fruit. The fruit of the *bael* tree is of particular interest due to its nutritional and medicinal properties. It has a hard, woody shell and contains a sweet, aromatic pulp that is rich in vitamins and minerals*. Bael* fruit is known for its high content of vitamins A, B, and C, along with important minerals such as calcium, potassium, and magnesium (Gupta and Meena, 2015). The pulp also contains bioactive compounds like tannins, flavonoids, and coumarins, which contribute to its therapeutic potential (Sharma *et al.*, 2014).

Traditionally, *bael* fruit has been used in various forms of traditional medicine to treat a wide range of ailments. It is highly valued in Ayurvedic medicine for its ability to aid digestion, reduce inflammation, and boost the immune system (Ganguly and Guha, 2008). The fruit is often consumed fresh or in the form of juices, sherbets, and jams. Its juice, in

particular, is known for its cooling properties and is commonly consumed during the summer months to prevent heatstroke (Patel and Roy, 2012). The health benefits of *bael* fruit extend beyond its nutritional content. Research has shown that *Bael* fruit exhibits strong antioxidant properties, which help in combating oxidative stress and reducing the risk of chronic diseases such as cardiovascular diseases and cancer (Kumar and Singh, 2010). Additionally, its antimicrobial properties make it effective against a variety of pathogens, there by contributing to its use in treating infections and improving overall health (Joshi *et al.*, 2009).

Bael fruit's potential as a functional food is being increasingly recognized. Its ability to regulate blood sugar levels has made it a popular choice for managing diabetes (Mandal and Kumar, 2011). Furthermore, the anti-inflammatory properties of *bael* fruit are beneficial in treating conditions such as arthritis and other inflammatory diseases (Singh and Chauhan, 2013). The dietary fiber content in *bael* also aids in maintaining digestive health, preventing constipation, and promoting a healthy gut microbiota (Rastogi and Mehrotra, 2015). Despite its numerous benefits, the consumption of *bael* fruit is limited due to its hard shell and the labor-intensive process of extracting the pulp. However, advancements in food processing technologies are making it easier to incorporate *Bael* fruit into various food products, thereby enhancing its availability and consumption (Kumar *et al.*, 2014). The versatility of *Bael* fruit in culinary applications is also noteworthy. It can be used to prepare a variety of products, including syrups, candies, and fermented beverages (Verma and Gupta, 2016). The fruit's unique flavor and nutritional profile make it an excellent ingredient for developing functional foods that cater to health-conscious consumers (Pandey and Kumar, 2018).

1.2 Statement of the problem

The increasing consumer demand for convenient and health-promoting beverages has driven interest in the development of functional drinks like *bael (Aegle marmelos)* Ready-to-Serve (RTS) beverages. Despite the well-documented nutritional and medicinal properties of *Bael* fruit, its potential in the RTS beverage market remains underexplored. This study aims to address the gap in the literature by investigating the nutritional composition and health benefits of *bael* RTS beverages. Previous research has highlighted the rich vitamin, mineral, and bioactive compound content of *bael,* which could offer significant health benefits, including antioxidant, anti-inflammatory, and digestive properties. However, there is limited scientific data on the formulation, consumer acceptance, and market potential of *bael* RTS beverages. Understanding these aspects is crucial for the successful commercialization and promotion of *bael* RTS beverages as a health-enhancing functional drink. This study seeks to fill this void by providing comprehensive insights into the nutritional profile, health benefits, and consumer appeal of *bael* RTS beverages.

1.3 Objectives of the study

1.3.1 General objective

The general objective of my class seminar is production process for *bael* (*Aegle marmelos*) Ready to Serve (RTS) beverage.

1.3.2 Specific objectives

1 To provide information about the production of *Bael* RTS beverage.
2 To provide information about the nutritional benefits of *Bale* RTS beverage.
3 To study identify and quantify the presence of essential vitamins, minerals, and other bioactive compounds in *Bael* RTS beverage.

Part II

Literature review

2.1 Introduction

Bael (Aegle marmelos) fruit is increasingly recognized for its therapeutic properties and nutritional benefits. Recent studies have explored the potential of *bael* fruit in the development of ready-to-serve (RTS) beverages, emphasizing its health benefits and consumer acceptance. The unique combination of bioactive compounds, vitamins, and minerals in *bael* fruit makes it a strong candidate for functional beverages. *Bael* fruit is rich in vitamins A and C, along with essential minerals like potassium and calcium, which significantly contribute to its health-promoting properties (Sharma *et al.*, 2016; Gupta and Kumar, 2020). Additionally, the fruit contains tannins, flavonoids, and coumarins, which exhibit antioxidant, anti-inflammatory, and antimicrobial activities (Sharma *et al.*, 2014).

The development of *bael* RTS beverages involves optimizing the fruit's sensory and nutritional qualities to ensure consumer acceptance and market success. Studies have demonstrated that *Bael* RTS beverages can be formulated to enhance flavor, aroma, and texture while retaining the fruit's nutritional profile. For instance, research by (Ganguly and Guha, 2008) highlighted the importance of balancing sweetness and acidity to achieve a palatable beverage. Furthermore, the addition of natural preservatives and flavor enhancers has been shown to improve the shelf life and sensory appeal of *bael* RTS beverages. The incorporation of *bael* pulp in RTS beverages not only provides a refreshing taste but also leverages the fruit's health benefits, making it an attractive option for health-conscious consumers (Patel and Roy, 2012).

The functional properties of *bael* RTS beverages extend beyond basic nutrition, offering potential therapeutic benefits. Research has indicated that regular consumption of *bael* RTS beverages can aid in digestion, regulate blood sugar levels, and boost immunity (Kumar and Singh, 2010). Moreover, the antioxidant properties of *bael* help in combating oxidative stress, thereby reducing the risk of chronic diseases such as cardiovascular diseases and cancer (Joshi *et al.*, 2009). Studies have also explored the potential of *bael* RTS beverages in managing diabetes and inflammatory conditions, owing to the fruit's anti-inflammatory and hypoglycemic effects (Mandal and Kumar, 2011). The growing body of evidence supporting the health benefits of *bael* RTS beverages underscores their potential as functional foods that promote overall health and well-being.

2.2 Composition/nutritional profile of *Bael* RTS beverages

Bael RTS beverage contains energy, protein, carbohydrates, dietary fiber and others nutrients which are given in table 2.1

Table 2.1 Composition/nutritional profile of *Bael* RTS beverages

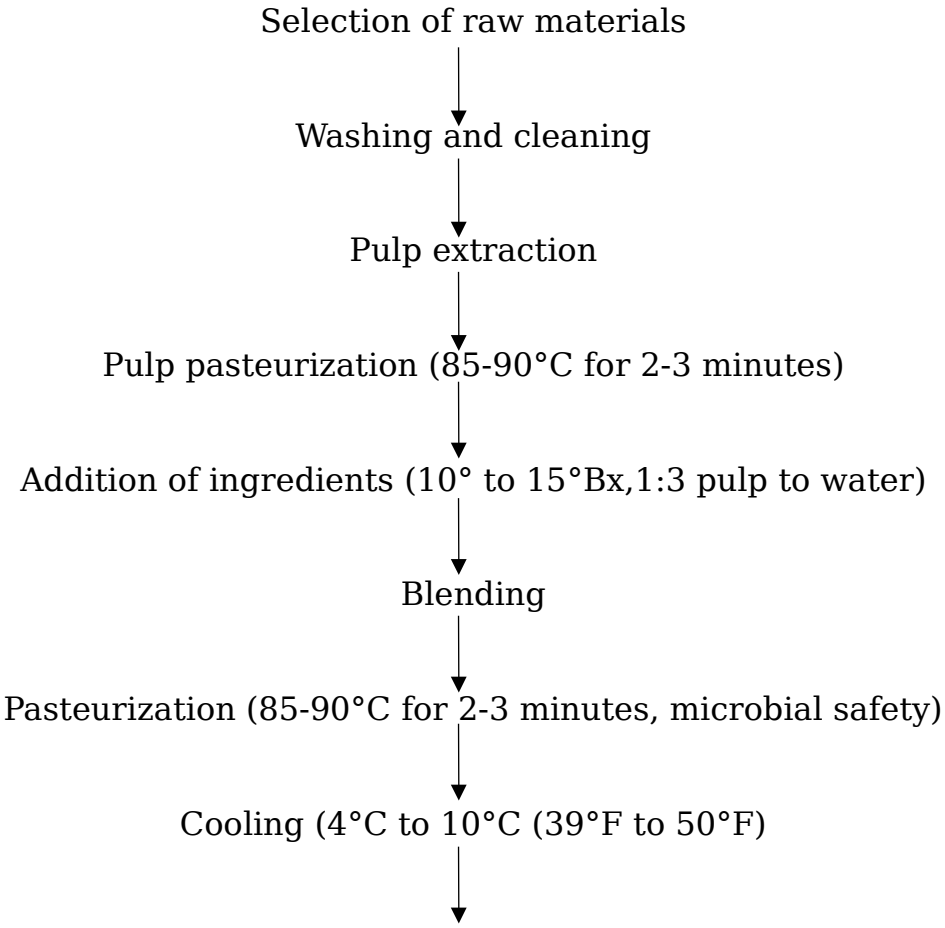
Nutrient	Amount per 100 ml
Energy	75 kcal
Carbohydrates	18 g
Protein	1 g
Fat	0.5 g
Dietary Fiber	2 g
Vitamin C	13 mg
Vitamin A	120 IU

Calcium	80 mg
Potassium	210 mg
Iron	1.2 mg

Source: Sharma *et al*. (2014)

2.3 Outline of *bael* RTS beverage and its description

Here is a flow chart outlining the production process of *bael* RTS beverages:


Selection of raw materials
Washing and cleaning
Pulp extraction
Pulp pasteurization (85-90°C for 2-3 minutes)
Addition of ingredients (10° to 15°Bx,1:3 pulp to water)
Blending
Pasteurization (85-90°C for 2-3 minutes, microbial safety)
Cooling (4°C to 10°C (39°F to 50°F)

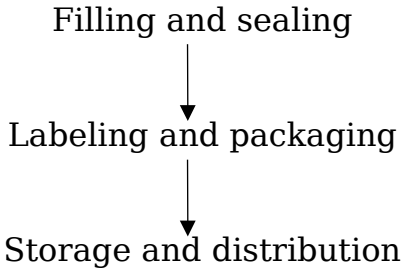


Fig 1.1: Flow chart for preparation of *Bael* RTS beverage

Source:

Patel and Roy (2012)

The outline of *bael* RTS (Ready-to-Serve) beverage production involves several key steps. First, ripe and high-quality *bael* fruits are selected, thoroughly washed, and cleaned to remove any impurities. The fruits are then cut, deseeded, and the pulp is extracted using a pulper. This pulp undergoes pasteurization by heating it to 85-90°C for 2-3 minutes to inactivate enzymes and microorganisms. The pasteurized pulp is then mixed with water, sugar, citric acid, and other preservatives, adjusting the mixture to a desired degree Brix, typically between 10° to 15° Brix. After blending the ingredients to achieve a homogeneous mixture, the beverage undergoes a second pasteurization at 85-90°C for 1-2 minutes to ensure microbial safety. The mixture is then filled into sterilized bottles or containers, sealed to prevent contamination, rapidly cooled, labeled, and packaged. The final product is stored in a cool, dry place before distribution to retailers and consumers (Patel and Roy, 2012).

2.4 Degree brix and *bael* RTS beverages

Degree Brix (°Brix) is a critical measurement in beverage production, representing the sugar content of a liquid solution. It is used to ensure consistency, sweetness, and overall quality in Ready-to-Serve (RTS) beverages, such as those made from *bael* fruit *(Aegle marmelos)*. *Bael*

RTS beverages typically have a Brix value ranging from 10° to 15°, depending on the desired sweetness and concentration of the final product. This measurement helps in adjusting the sugar content during formulation, there by influencing taste and shelf-life (Smith *et al.*, 2021). Proper Brix measurement is essential for achieving a balanced flavor profile and maintaining product quality throughout distribution.

2.5 Methods of production of *bael* RTS beverage

The methods of production of *bael* RTS beverage can be broadly categorized into traditional and modern techniques, each with its own advantages and limitations are

2.5.1 Traditional methods

Traditional methods of producing *bael* RTS beverages involve the manual extraction of pulp from ripe *Bael* fruits, which is then mixed with water, sugar, and sometimes spices to enhance flavor. This mixture is often strained to remove fibrous content and seeds, resulting in a smooth beverage. However, traditional methods may vary in consistency and may not always ensure the microbiological safety of the product (Ganguly and Guha, 2008).

2.5.2 Modern methods

Modern production techniques incorporate more controlled and standardized processes, including pasteurization and the use of preservatives to extend shelf life. These methods often involve mechanical extraction of *bael* pulp, followed by blending with other ingredients in precise proportions. The use of homogenization, pasteurization, and aseptic packaging helps in maintaining the nutritional quality and safety of the beverage. Advanced techniques also explore the addition of natural

preservatives and stabilizers to improve shelf life without compromising the nutritional profile (Patel and Roy, 2012).

2.5.3 Specific production methods

1. Mechanical extraction and filtration

This method uses mechanical equipment to extract *bael* pulp, followed by filtration to remove solid residues. The pulp is then mixed with water, sugar, and other ingredients (Ganguly and Guha, 2008).

2. Pasteurization and aseptic packaging

This involves heating the *bael* juice mixture to a specific temperature to kill pathogens, followed by cooling and packaging in sterile conditions to prevent contamination (Patel and Roy, 2012).

3. Incorporation of natural preservatives

Natural preservatives such as citric acid and ascorbic acid are added to enhance the shelf life and maintain the quality of the *bael* RTS beverage (Sharma *et al.*, 2014).

4. Blending with functional ingredients

The addition of functional ingredients like honey, ginger, or other fruit extracts can enhance the nutritional and sensory properties of the *bael* RTS beverage (Patel and Roy, 2012).

2.6 Storage of *bael* RTS beverage

The storage stability of *bael (Aegle marmelos)* RTS beverages is a critical factor influencing their shelf life and consumer acceptance. Effective storage solutions ensure that the beverage retains its nutritional quality, sensory properties, and microbiological safety over time. Various studies have explored different preservation techniques to enhance the shelf life of *Bael* RTS beverages.

2.6.1 Refrigeration

Refrigeration is one of the most common methods used to prolong the shelf life of *bael* RTS beverages. By storing the beverage at low temperatures, the growth of spoilage microorganisms is significantly slowed down, helping to maintain the product's freshness and nutritional value. However, refrigeration alone may not be sufficient for long-term storage, as enzymatic activities can still lead to quality degradation over extended periods (Patel and Roy, 2012).

2.6.2 Pasteurization

Pasteurization is widely employed to enhance the microbiological safety and shelf stability of *bael* RTS beverages. This process involves heating the beverage to a specific temperature for a defined duration to inactivate pathogenic microorganisms and enzymes that could cause spoilage. Pasteurization effectively extends the shelf life while preserving the beverage's flavor, color, and nutritional content. After pasteurization, the beverage is often packaged aseptically to prevent contamination (Sharma *et al.*, 2014)

2.6.3 Use of natural preservatives

The addition of natural preservatives such as citric acid, ascorbic acid, and other antioxidant compounds can further enhance the shelf life of *bael* RTS beverages. These natural preservatives help to inhibit microbial growth and oxidative reactions, which can deteriorate the quality of the beverage over time. Research has shown that natural preservatives are effective in maintaining the sensory and nutritional qualities of *bael* RTS beverages during storage (Ganguly and Guha, 2008).

2.6.4 Modified atmosphere packaging (MAP)

Modified Atmosphere Packaging (MAP) is another technique that has been explored for storing *bael* RTS beverages. By altering the gaseous environment within the packaging, MAP can significantly reduce the rate of oxidative spoilage and microbial growth. This method is particularly beneficial for extending the shelf life of beverages without the need for chemical preservatives (Patel and Roy, 2012).

2.7 Health benefits of *bael* RTS beverage

Bael (Aegle marmelos) RTS beverages have garnered significant attention due to their impressive health benefits, attributed to the rich bioactive compounds present in *bael* fruit. The beverage offers numerous advantages, including antioxidant, anti-inflammatory, and digestive health benefits, making it a functional drink with therapeutic potential.

2.7.1 Antioxidant properties

Bael RTS beverages are rich in antioxidants, which play a crucial role in neutralizing free radicals in the body. Free radicals are unstable molecules that can cause oxidative stress, leading to chronic diseases such as cancer and cardiovascular diseases. The high content of phenolic compounds, flavonoids, and vitamins like vitamin C in *bael* fruit contributes to its strong antioxidant activity. Regular consumption of *bael* RTS beverages can help in reducing oxidative stress and improving overall health (Sharma *et al.*, 2014).

2.7.2 Anti-inflammatory benefits

The anti-inflammatory properties of *bael* RTS beverages are well-documented. The fruit contains various bioactive compounds, including coumarins and alkaloids, which exhibit significant anti-inflammatory

effects. These compounds help in reducing inflammation and pain associated with various inflammatory conditions, such as arthritis and inflammatory bowel disease. Incorporating *bael* RTS beverages into the diet can aid in managing inflammation and promoting better health (Ganguly and Guha, 2008).

2.7.3 Digestive health

Bael RTS beverages are known for their digestive health benefits. The beverage acts as a natural remedy for digestive disorders such as constipation, diarrhea, and irritable bowel syndrome. The high fiber content in *bael* helps in regulating bowel movements and promoting gut health. Additionally, the presence of tannins and pectin's in *bael* fruit aids in soothing the gastrointestinal tract and improving digestion. Consuming *bael* RTS beverages regularly can enhance digestive health and alleviate common digestive issues (Patel and Roy, 2012).

Part III

Conclusion

The study on the nutritional and health benefits of *bael (Aegle marmelos)* Ready to Serve (RTS) beverage highlights its potential as a functional drink with significant therapeutic properties. *Bael* fruit is rich in essential nutrients, including vitamins A and C, calcium, and potassium, along with bioactive compounds like phenolics, flavonoids, and tannins. These components contribute to its strong antioxidant, anti-inflammatory, and digestive health benefits. The regular consumption of *bael* RTS beverages can help in reducing oxidative stress, managing inflammation, and promoting gut health, making it a valuable addition to a balanced diet.

The production and storage of *bael* RTS beverages can be optimized through methods such as pasteurization, refrigeration, and the use of natural preservatives to maintain their nutritional quality and extend shelf life. This study underscores the importance of developing and promoting *bael* RTS beverages to meet the increasing consumer demand for health-promoting and convenient functional beverages. By leveraging the nutritional and therapeutic benefits of *bael*, these beverages can play a crucial role in enhancing public health and wellness.

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